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MULTI-SCALE NUMERICAL SIMULATION OF THE THERMAL-MECHANICAL BEHAVIORS FOR CERAMIC COMPOSITES REINFORCED WITH NONO-FIBER

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Summary: The different thermal expansion coefficients for ceramic matrix and nano-fiber in ceramic composites can produce obvious thermal residual stress with the changes of temperature, which degenerate the thermal-mechanical properties of the composites. The approaches reported in literature devoted to the investigation of nano-composite systems cover different length scales, ranging from atomistic to continuum mechanics, and it is difficult to find a suitable method to predict the effective mechanical properties such as the thermal expansion coefficient and effective elastic modulus for these complex and heterogeneous materials. In fact, the computational models are very helpful for a complete investigation of nano-composites to predict the overall mechanical behavior of the composites, and to provide a reliable design for such materials. In this paper, the analyzed equations are established by using the multi-scale macro-microscopic homogenization methods (HM) for represent volume element with debonding interface to analyze the main factors to affect the mechanical behaviors of ceramic composites reinforced with nano-fiber. The changes of the material parameters for nano-fiber with different array methods are considered in the model. The transverse and longitudinal residual stress and the thermal expansion coefficient are calculated, and the results are compared well with those from the classical Turner and Kerner models, which show that the aspect ratio of the nano-fiber and the interfacial parameters between nano-fiber and ceramic matrix have obvious influences on the mechanical properties of ceramic composites reinforced with nano-fiber, and the transverse and longitudinal mechanical properties have great differences for the change of the array methods of nano-fiber and the evolution of the interfacial debonding.